International Journal of Engineering & Technology, 7 (4) (2018) 4838-4840

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET
doi: 10.14419/ijet.v7i4.24037
Research paper

Fiber Communication System Based on FBG As Dispersion Compensator, Design And Experimental Setup

Shehab A. Kadhim [1], Karrar A. Kazr [2], Alaa H. Ali [2], Aseel I. Mahmood [1] *

[1] *Ministry of Science and Technology—Materials Research Directorate- Laser and Optoelectronics Research Center, Baghdad, Iraq*
[2] *Electrical Engineering Department, Technical University, Baghdad, Iraq*
**Corresponding author E-mail: aseelibrahim208@gmail.com*

Abstract

The technological progress in the means of transmission of information is very fast and it becomes necessary to obtain high speed in data transmission and high data rate. The developments in optical communication systems cover these needs, so the developments in these systems become an urgent need. However, despite all characteristics and advantages of optical communication systems, there is the dispersion problem. In this research we will get rid of this problem in practice through the use of fiber Bragg grating connected to two separate and different wavelengths then connecting them to the Wavelength Division Multiplexing and send them to a distance of 3 Km then calculate the amount of dispersion in the signal with and without fiber Bragg grating and compare the results.

Keywords: *Fiber Bragg Gratings; Dispersion Compensation; Wavelength Division Multiplexing; Fiber Bragg Grating Applications.*

1. Introduction

Wavelength Division Multiplexing (WDM) technique considered as one of the most important and promising concepts for communication system of high capacity. Optical networks that's depend on WDM support multiple signals with different frequencies or wavelengths in a single fiber [1], [2]. WDM is similar to Frequency Division Multiplexing; optical fiber data system requires high data rate and large number of transmission channels. The higher bandwidth of optical network compare to copper based networks make it very effective in network applications [3]. The chromatic dispersion appear to make serious problem in optical fiber communication system because it cause significant distortion in pulses during transmission. To overcome this problem and then enhancing the quality of transmission, dispersion compensators are required. Optical Fiber Bragg Gratings (FBG) are used to compensate dispersion. FBG reflects different wavelengths (or frequencies) at different significant points along its length [4], [5]. As the reflected wavelength, change regarding to the change of the period grating the reflected spectrum broadens. There are many types of FBG's, like chirped FBG introduce different wavelengths(frequencies) so they very suited to use as a dispersion compensation elements for one wavelength of multiple ones. In general FBG's have many features which make them very suitable in dispersion compensation application like fiber geometry, low insertion loss, high return loss or extinction, and potentially low cost [6], [7].
Several dispersion compensation techniques have been proposed: a pre-chirping of light source, introducing a spectral inversion at the middle of transmission span [8], a chirped fiber Bragg grating [Sudo, 1998], and dispersion compensating fiber [9]. Optical Fiber Bragg Gratings (FBG) are used to compensate dispersion. Grating reflects different wavelengths (or frequencies) at different points along its length [5]. The rejected spectrum broadens as the reflected wavelength changes with the grating period. Effectively, a chirped Bragg grating introduces different delays at different frequencies. Chirped gratings are ideally suited to compensate the dispersion for individual wavelength than multiple wavelengths. Fiber geometry, low insertion loss, high return loss or extinction, and potentially low cost are the advantages of FBG over other technologies [6]. The research aims to minimize dispersion effect in fiber optics communication links by implementation (FBG) as a dispersion compensator element.
The technique of WDM in optical fiber communication system multiplexed many optical signals of laser light in one signal. Bidirectional communications over one line of fiber, and multiplication of capacity could be achieved by this technique. The wavelength and frequency are gathered by simple and well known relationship, in which the product of frequency and wavelength equals the speed of light. The multiplexer is used at WDM system at the transmitter side while the de-multiplexer at the receiver side
The modern system multiplexed over 160 signals while the earlier one was combine just two. The reason behind chromatic dispersion in optical fiber is that light is propagate in different speeds so the light will have different impulse and arrive to detector at different time [9], [10].

2. Experimental Work

The setup had been implemented to make sure that the signal is exposed to dispersion and their properties are known by connecting two different sources at the wavelength (1310nm), (1550nm), and multiplexing them by the WDM with FBG with Bragg wavelength 1550 nm and 1310 nm. Then we send the signal produced through the optical fiber of length 3 km. we address the dispersion in the signal by connecting the FBG to improve the signal, data from a programmable Optical Spectrum Analyser OSA from (Thorlabs Inc.) with resolution 0.01 nm. Figures 1 and 2 showing the schematic diagram of dispersion compensation experiment without and with FBG respectively, while figure 3 shows photographic image for the submitted setup.

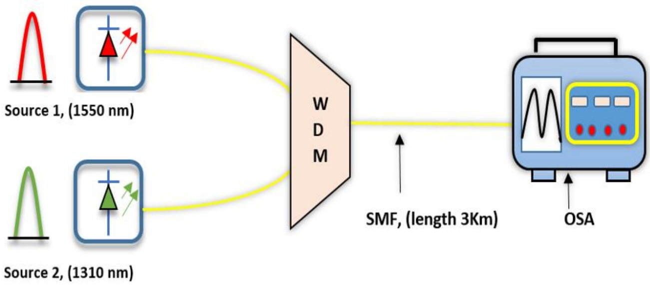


Fig. 1: Blok Diagram of Optical Fiber Transmission System without FBG.

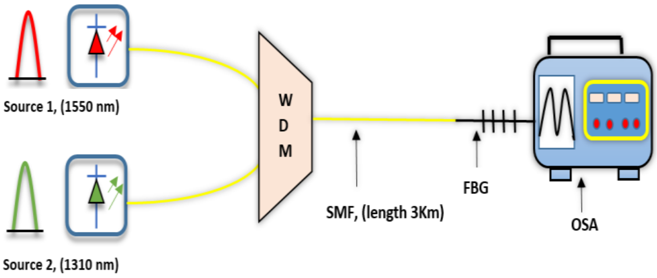


Fig. 2: Blok Diagram Optical Fiber Transmission System with FBG.

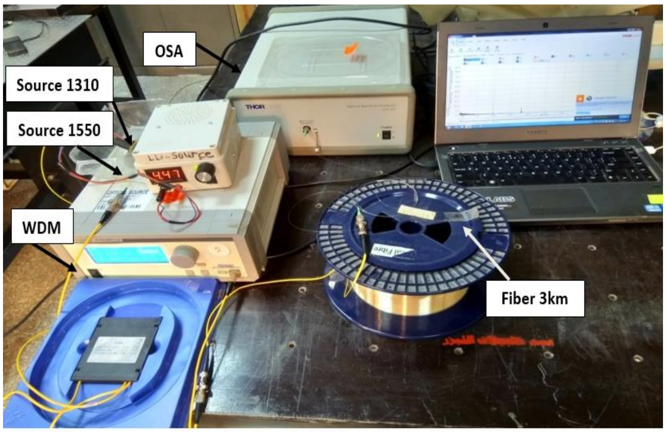


Fig. 3: Photographic Image of Experimental Setup.

3. Results and Discussions

Significantly, attenuation and dispersion effects directly to bit rate and link range of fiber optic communication system. Standard SMF manufactured to optimize transmission by eliminating dispersion at 1310nm wavelength, while for 1550nm the dispersion is a limiting factor in both single channel or WDM system. Figure 4 shows the effect on reducing dispersion for 1550nm wavelength in case of using FBG as a dispersion compensator in compare without using it. Figure 5, the same cases but for 1310nm wavelength. While figure 6 shows the all link dispersion effect of length 3 Km for the two cases.

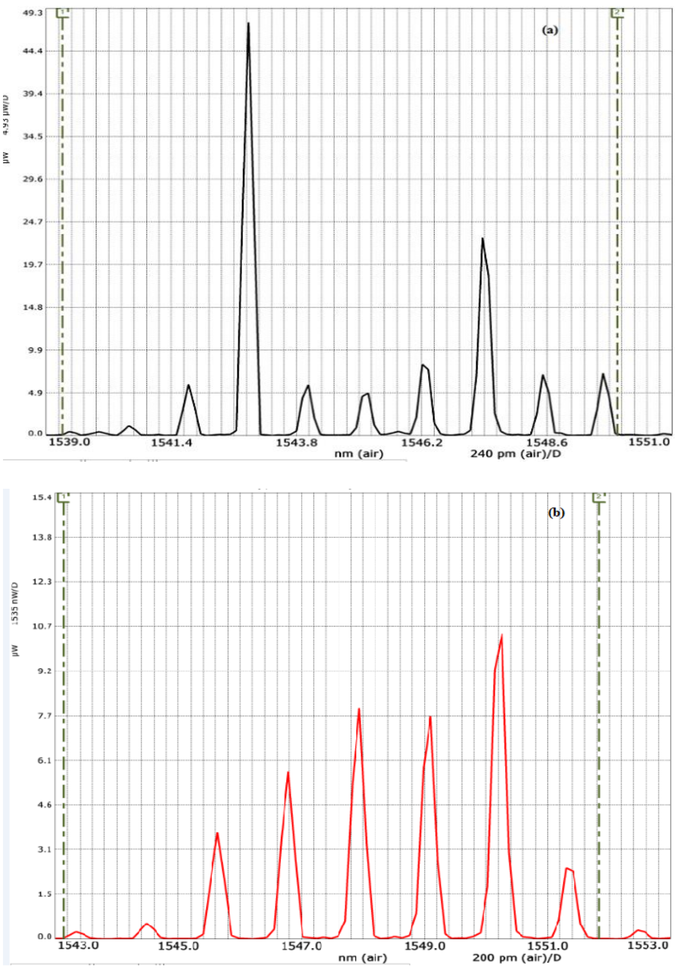
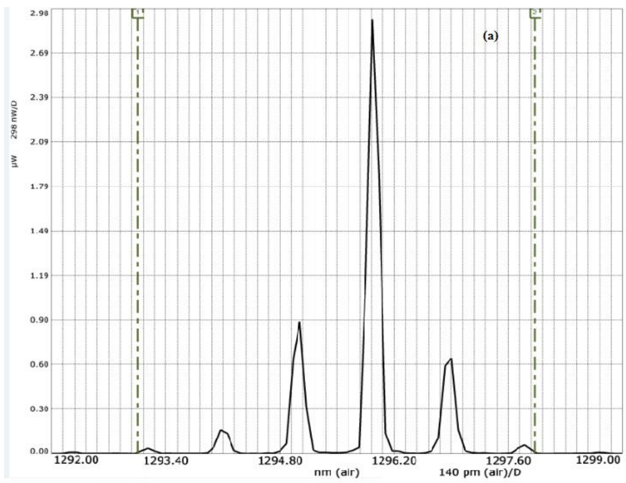


Fig. 4: The 1550nm Link Dispersion Effect of Length 3 Km (a) Without Using FBG, (b) With Using FBG.



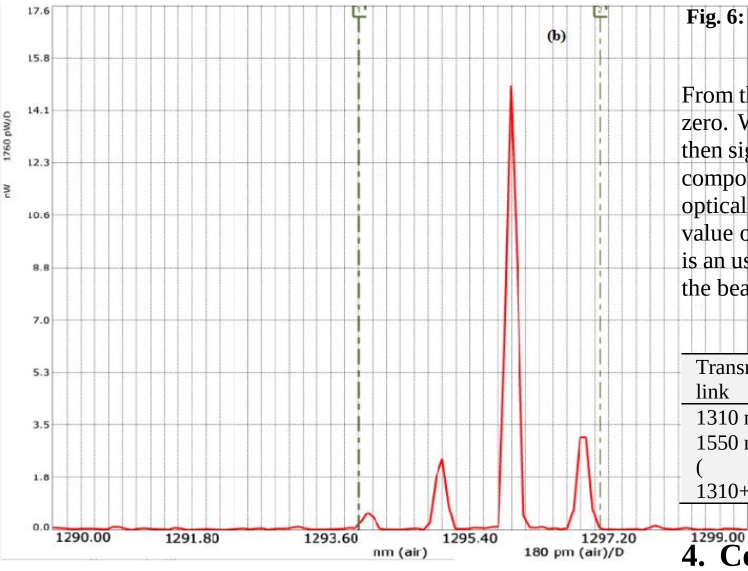
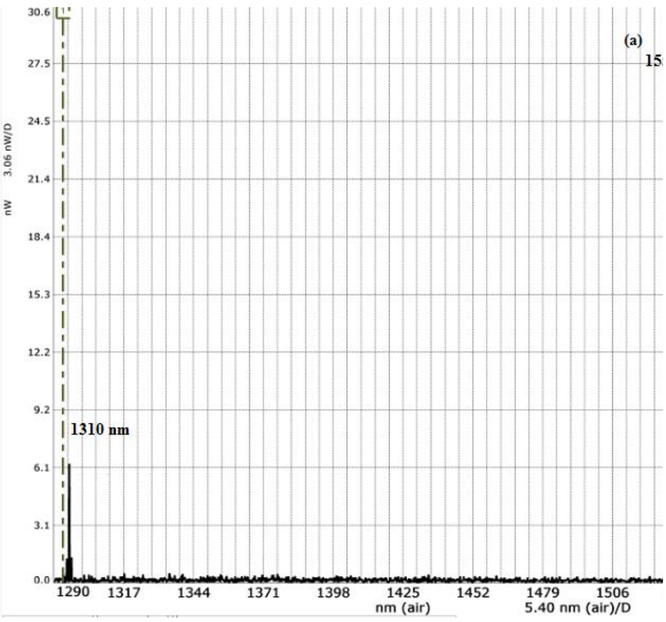


Fig. 5: The 1310 nm Link Dispersion Effect of Length 3 Km (a) Without Using FBG, (b) With Using FBG.



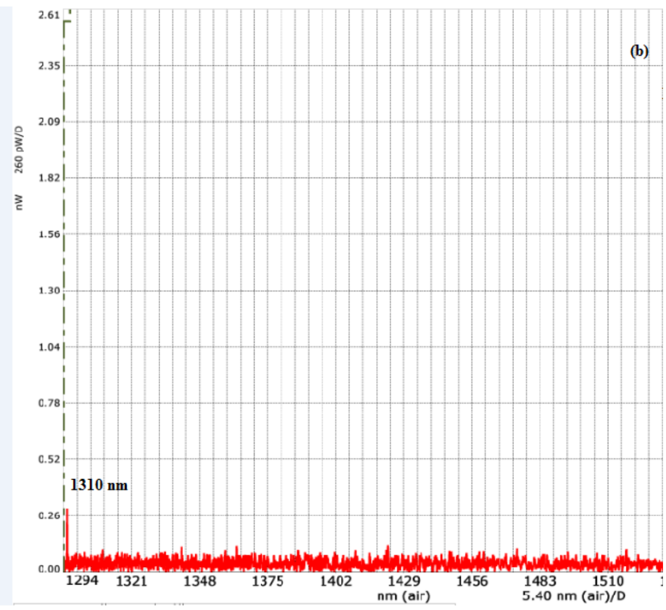


Fig. 6: The All Link Dispersion Effect of Length 3 Km (a) Without Using FBG, (b) With Using FBG.

From the experimental result, the dispersion at initial point is about zero. When the signal passes through 3 km long optical channel then signal wave dispersed, the value of dispersion is reduced. FBG component used for minimizing the dispersion, from the received optical signal the dispersion it is shown in above waveforms. The value of dispersion after FBG is reduced. Hence fiber Brag grating is an useful component for minimizing the dispersion table 1 shows the beam width in nm for all cases.

Table 1: The Beam Width of Optical Transmission Links

Transmission link	Beam width in nm without FBG	Beam width in nm with FBG
1310 nm	4.876	3.126
1550 nm	10.64	9.58
(1310+1550)nm	261.151	257.617

4. Conclusions

In this work, dispersion compensation had been studied for two different wavelengths 1310nm and 1550 nm which they are very important windows in optical communications systems with and without utilizing fiber Bragg grating. we have confirmed through the results that the proposed design is affected by dispersion especially in long-distance communication systems. and we can control this problem by compensate this dispersion utilizing fiber Bragg gratings.

References

[1] Sharma V., and Kaur D., "Review on Multiplexing Techniques in Optical Communication Systems" European Scientific Journal, Vol.2 ISSN: 1857 – 7881, (2015), pp.88-94.

[2] P1 G., and Thomas S., "Performance Analysis of Dispersion Compensation using FBG and DCF in WDM Systems", International Journal of Advanced Research in Computer and Communication Engineering, Vol. 4, (2015),Issue 10.

[3] Watanabe Sh., Kato T., Okabe R., Elschner R.; Ludwig R., and Schubert C., "ALL-Optical Data Frequency Multiplexing on single-wavelength carrier Light by Sequentially Provided Cross-Phase Modulation in Fiber." IEEE journal of Selected Topics in Quantum Electronics, Vol. 18, No. 2, (2012), pp.577-584. https://doi.org/10.1109/JSTQE.2011.2111358.

[4] Arora O., and Garg A., "Impact of Fiber Bragg Grating as Dispersion Compensator on the Receiver Characteristics", Global Journal of Researches in Engineering Electrical and Electronics Engineering, Vol.11, (2011), 19-23.

[5] Hill K. and Meltz G., "Fiber Bragg grating technology: Fundamentals and overview," J. Light w. Technol., vol. 15, no. 8 (1997), pp. 1263–1276, Erdogan T., "Fiber grating spectra," J. Light w. Technol., vol. 15, no. 8, (1997), pp. 1277–1294.

[6] Prasad B., Patra K., Barpanda K.," Performance Analysis of Fiber Optical Communication using Fiber Bragg Grating as Dispersion Compensator", International Journal of Advanced Research Electrical,Electronics and Instrumentation Engineering ,Vol. 5, (2016) Issue 4.

[7] O'Flaherty F.J., Ghassemlooy Z., Mangat P., and Dowker K. "Temperature Characterization of Long-Period Gratings for Sensor Applications" Microwave & Optical Technology Letters, vol. 42, no. 5, (2004) pp. 402-405. https://doi.org/10.1002/mop.20317.

[8] Jopson R. "Compensation of fiber chromatic dispersion by spectral inversion", Electron. Lett, Vol.29, (1993) pp.576- 578. https://doi.org/10.1049/el:19930387.

[9] Nishide K. "1.55 µm Single Mode Fibers with Large Chromatic Dispersion", IEICE spring conference, C-575, (1989).

[10] Wójcik, W., Kisała P., Yussupova P., Kussambayeva N., Kashaganova G. and Harasim D. , "Analysis of the Possibilities for Using a Uniform Bragg Grating in a Tunable Dispersion Compensator", Intl Journal Of Electronics And Telecommunications, Vol. 61, No. 4, (2015) Pp. 381-387 https://doi.org/10.2478/eletel-2015-0050.